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ABSTRACT

The hypothesis that word context reduces visual rather than acoustic confusion between possible targets was tested in a series of experiments. All involved tachistoscopic presentation of letter strings followed by a pattern mask. Data from eight college students showed that target letters that are confusable only visually and acoustically ("b" and "p") produced no greater word superiority effect (WSE) than targets that are confusable only visually ("c" and "g"). Accordingly, six new subjects demonstrated a WSE with "c" and "g," but none with acoustically similar but visually dissimilar "d" and "t." A final experiment with eight new subjects showed a WSE with only nonhomophones ("dusk"-"duck"). It was concluded that the WSE has a visual but not an acoustic basis. However, if targets are acoustically identical as well as visually confusable, the WSE is eliminated. Apparently some disruption, possibly in storage, occurs with acoustically identical targets but not with acoustically similar ones. (RL)

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Visual and Acoustic Confusability of Target Letters and the Word Superiority Effect

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A letter in a word can be identified more accurately than a letter in a string of unrelated letters if the brief exposure is followed by a pattern mask. A number of explanations have been proposed for this word superiority effect. One type of explanation argues that letters in a word can be grouped for acoustic encoding in a way that is not possible with unrelated letters, and gain their advantage in identifiability for this reason. Another type of explanation refers to familiar visual features of words which provide the advantage over unfamiliar letter strings. While people may be able to use either acoustic or visual information to advantage as the situation requires, one might ask which is more basic in its contribution to the word superiority effect.

One way to approach the issue would be to vary independently the acoustic and graphemic confusability among possible target letters. When targets are not confusable in either way (e.g. R vs. L), the word superiority effect seems due entirely to fewer confusions in words than in the unrelated letter strings between letters in the target position and other positions in

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the string (cf. Estes, 1975). To avoid this basis for the effect, target letters can be presented in a fixed position in a trigram or quadrigram. Purcell, Stanovich, and Spector (1978) found a word superiority using A_E as word strings and V_H as unrelated letter strings, with C, G, P, and R as possible targets in the center position. However, Paap and Newsome (1980) placed selected digits (3, 6, 8, or 9) between the same sets of flanking letters and found slightly lower performance with the V and H flankers, leading them to conclude that the original effect was due to differential lateral masking. Nevertheless, the performance difference with the digits was only about half that observed with the letter targets. Moreover, featural differences between the letter and digit targets could be relevant to the results.

If the V and H flankers consistently provide more lateral interference than do the A and E flankers, the difference should be observed whatever the target set. However, we unsuccessfully attempted to produce superior performance with the A_E strings by having subjects initially practice pronouncing AQE as "ache" and AJE "age." According to Townsend's (1971) confusion matrix of block capital letters, the Q and J are less mutually confusable than the average randomly selected letter is with either one. After 30 practice pronounciations of each string, eight subjects each viewed 64 tachistoscopic presentations of each of the A_E and V_H strings, with the Q and J embedded between each flanking pair equally often. Forty-eight practice exposures preceded the criterion exposures, and a postexposure mask (an # character replacing each letter originally exposed) terminated the presentation after a string exposure duration which allowed 75% overall accuracy at the beginning of the criterion set. Thereafter,

string duration was adjusted to maintain 75% accuracy only between 16 trial blocks during which each string was presented four times. Target identification was no better with the A_E strings than with the V_H strings, with mean accuracy of .728 for the former and .761 for the latter ($t(7) = .31$, $p > .10$). Thus superior performance with A_E strings due to more lateral interference from the V and H flankers does not necessarily occur.

In the first experiment in which we systematically varied visual and acoustic confusability of target letters, four targets were selected to be presented in the A_E and V_H strings. Townsend's (1971) matrix shows C and G to be highly mutually confusable, and are B and P. B and P are similar acoustically, while C and G are not (Jakobson, Fant, & Halle, 1951). Under exposure conditions identical to those described before, eight subjects tended to identify targets in the A_E strings better than in the V_H strings ($F(1,7) = 10.39$, $p < .025$). Accuracy of identification of each target in each string is shown in Table 1. The obvious overall superior identification of P targets was supported statistically ($F(2,14) = 5.81$, $p < .025$), although there was no interaction between flankers and target letters ($F(2,14) = 1.36$, $p > .10$). Individual comparisons showed that while the word superiority with the C/G target set appears smaller than with the B/P set, it is statistically at least as strong ($t(7) = 2.70$, and $t(7) = 2.37$, respectively, both $p < .05$). Apparently, visual confusability is sufficient to produce the word superiority, and acoustic confusability adds little.

Insert Table 1 about here

To strengthen the conclusion, six new subjects were each shown C and G as targets, which once again are visually but not acoustically confusable,

and D and T, which are acoustically but not visually confusable. If visual confusability is primary and acoustic confusability adds nothing, a word superiority would be expected with C and G but not with D and T. Consonant with this expectation, under presentation conditions identical to those used before, the interaction between flankers and target sets (C/G vs. D/T) was significant ($F(1,5) = 6.69$, $p < .05$). As shown in Table 2, there was no difference in accuracy between the two sets of flankers for the D/T targets, but a large difference for the C/G targets. The superior overall accuracy on the visually nonconfusable D/T targets led to a significant main effect of target sets ($F(1,5) = 64.63$, $p < .001$).

Insert Table 2 about here

Is the acoustic confusability of targets therefore unrelated to the word superiority effect? To further investigate this issue, and to demonstrate word superiority with a fixed target set in a predesignated position in strings other than the A_E and V_H, a final experiment was conducted. The target letter, either I, Y, C, or S, was presented as the third letter of a quadrigram. The homophones BOYS-BOIS and VICE-VISE were used (BOIS is readily recognized as being pronounced in the same way as BOYS in Boise, Idaho). Nonhomophones containing the targets were CRYS-CRIS and DUCK-DUSK. For each pronounceable string was selected an unpronounceable control string with the target letter in the same position. Some attempt was made to make the features in the nontarget positions similar in the corresponding strings (see Figure 1). C and S are visually similar, as are I and Y. Whether they are acoustically identical depends on the context. Eight new subjects, run under conditions identical to those described before, produced results yielding

a significant interaction between pronounceability and homophone/nonhomophone sets (including controls) ($F(1,7) = 6.23$, $p < .05$). This means appear in Table 3. Individual comparisons showed a word superiority only for non-homophones ($t(7) = 3.92$, $p < .01$). Targets within nonhomophones were also identified significantly more accurately than targets within homophones ($t(7) = 3.21$, $p < .025$). No significant differences existed for nonword strings associated with homophones and those associated with nonhomophones, nor for targets appearing in homophones and those in their controls (both $ps > .10$). A confusion matrix for each target of the homophones and nonhomophones appears as Table 4. Notice that the tendency for each letter to be reported as its visually confusable counterpart is less apparent with the homophones. Perhaps the acoustic identity between pairs of letters for the homophones provided interference which led to less certainty about the visual features of the target.

Insert Figure 1 about here

Insert Table 3 about here

Insert Table 4 about here

The results just described were obtained with a limited number of stimulus strings, and certainly cannot be considered conclusive. Nevertheless, the patterns of accuracy in letter identification suggest that:

1. Word superiority effects can occur with a predesignated set of targets appearing in a fixed position in letter strings.

2. Target letters must be visually confusable for the word superiority effect to emerge under the current conditions. Acoustic confusability alone does not produce the effect.

3. If targets are acoustically identical as well as visually confusable, the word superiority is eliminated. Apparently some disruption (perhaps in storage?) occurs when the targets are acoustically identical which does not occur when the targets are merely acoustically similar.

Pursuant to this final point, a set of experiments soon to be published (Chastain, in press) indicates the involvement in the word superiority effect of the brief period between the presentation and the report. During this time codes for the target letter are developed and stored. Both graphemic and acoustic codes seem to appear. If a letter is added to the string with the postexposure mask which changes either code, accuracy suffers.

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Table 1

Mean Percentage of Errors for Each Target Letter in Each Context in Experiment 1

Context	Target Letters			
	C	G	B	P
V_H	31.3	29.7	35.9	16.4
A_E	22.7	28.1	14.8	4.7
Difference	8.6	1.6	21.9	11.7

Table 2

Mean Percentage of Errors for Each Target Letter in Each Context in Experiment 2

Context	Target Letters			
	C	G	D	T
V_H	36.5	49.0	13.5	13.5
A_E	21.9	33.3	10.4	16.6
Difference	14.6	15.7	3.1	- 3.1

Table 3

Mean Percentage of Errors for Targets

in Each Type of Context in Experiment 3

	Pronounceable Strings	Controls
Homophones	26.6	20.8
Nonhomophones	17.2	27.6

Table 4

Proportion of Incorrect Responses for Homophones and Nonhomophones

in Experiment 3

	Homophones		(Nonhomophones)	
Target Letter	Response			
	C	S	I	Y
C	- (-)	.25 (.80)	.00 (.00)	.75 (.20)
S	.83 (1.0)	- (-)	.00 (.00)	.17 (.00)
I	.00 (.29)	.55 (.14)	- (-)	.45 (.57)
Y	.00 (.25)	.67 (.25)	.33 (.50)	- (-)

Figure 1

Stimulus Strings in Experiment 3

Homophones	Homophone Controls
VICE	NTCH
VISE	NTSH
BOIS	DQIG
BOYS	DQYG
Nonhomophones	**Nonhomophone Controls**
DUCK	OPCX
DUSK	OPSX
CRIS	OBIJ
CRYS	OBYJ